# 3-F NEARSHORE ALIGNMENT AND CONSTRUCTION METHODS ALTERNATIVES

FINAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

**APPENDICES** 



## Final

# Appendix 3-F Nearshore Alignment and Construction Method Alternatives

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# **Executive Summary**

This memorandum presents an engineering evaluation of nearshore construction alternatives and the potential outfall alignments for the Brightwater Marine Outfall. The alignments originate from either the western-most, land-based conveyance tunnel terminus locations at the proposed Portal Siting Area 19 for alternative outfall Zone 7S or from the proposed Unocal plant site effluent pump station for alternative outfall Zone 6. The outfall construction alternatives that have been evaluated include trenchless and open-trench methods. The evaluation in this memorandum includes technical advisor input based on findings presented in the *Brightwater Marine Outfall Conceptual Design Report* (Parametrix, 2002a) and the *Draft Environmental Impact Statement* (DEIS) (King County, 2002b). These documents contain the most current information regarding the overall Brightwater project description along with more detailed outfall predesign analyses.

Three potential trenchless construction methods, Conventional Tunneling, Microtunneling, and Horizontal Directional Drilling (HDD) are discussed in this memorandum. Each method is applicable for use in glacial soils and capable of balancing pressure within the excavation to maintain a stable tunnel face and prevent the inflow of Puget Sound water at the water depths proposed. Pipe installation utilizing HDD for the anticipated pipe size and alignment length is not currently viable since it would require two or more smaller diameter pipelines resulting in the methodology not being cost competitive.

Open-trench excavation is the predominant construction method for the installation of marine outfall pipelines in Puget Sound. Both barge and trestle mounted trench excavation are discussed in this memorandum. However, it is unlikely that trestle mounted trench excavation would be utilized due to the resulting increase in damage or disruption to the seafloor, the construction duration, and cost.

Factors impacting selection of the nearshore outfall alignment and construction method include staging area characteristics, length of the nearshore outfall segment, environmental resources along the alignment, and the presence and extent of contamination, if any. Sensitivity of the construction method to subsurface ground conditions also impacts the selection of the preferred construction method. Based on an evaluation of these factors, preferred construction methods were selected for outfalls in both Zones 6 and 7S from the potential alignments and construction methods discussed in this Technical Memorandum. These preferred construction methods are summarized for each potential staging area in Table 1.

Table 1.
Preferred Construction Methods

| Staging Area (Outfall Zone) | Onshore Construction | Nearshore Construction |
|-----------------------------|----------------------|------------------------|
| Unocal Plant Site (Zone 6)  | Open Trench          | Open Trench            |
| Richmond Beach (Zone 7S)    | Microtunnel          | Microtunnel            |

| Staging Area (Outfall Zone) | Onshore Construction | Nearshore Construction |
|-----------------------------|----------------------|------------------------|
| Upper Point Wells (Zone 7S) | Open Trench          | Open Trench            |
| Lower Point Wells (Zone 7S) | Open Trench          | Open Trench            |

Some outfall alignments may also require an onshore pipeline segment, either from the conveyance terminus (Zone 7S) or the Unocal plant site effluent pump station (Zone 6), to the shoreline where nearshore construction would begin. Onshore pipeline segments may be installed using either open trench or trenchless methods as described in this Technical Memorandum.

# Recommendation(s)

Based on the analysis included in this report, and consideration for minimizing disturbance to nearshore marine habitat, we conclude and make recommendations consistent with the following:

- 1. The proposed Lower Point Wells portal site alternative (Parcel C) appears to offer the best opportunity for outfall construction methods to minimize disturbance to the nearshore environmental resources that are predominantly located in the areas south of Point Wells toward Richmond Beach.<sup>1</sup>
- 2. Open-trench construction is the preferred method of construction through the nearshore along the proposed Upper Point Wells, Lower Point Wells, and Unocal plant site alignments. Open-trench construction is a proven construction method for outfall installation in the Puget Sound and is less sensitive to potential subsurface anomalies than microtunnel construction.
- 3. Because of the substantial marine habitat areas that could be damaged by the construction of an open-trench pipeline from the Richmond Beach area (Parcel E), any further considerations of a conveyance portal in this vicinity should carry with it an understanding that construction through the nearshore will likely be limited to viable trenchless methods.

<sup>&</sup>lt;sup>1</sup> Candidate portal sites were selected based upon the screening process presented in the *Level 1 and 2 Portal Screening Documentation* (King County, 2003a). Final selection (Level 3 Screening) of the portal site will be based upon input (engineering, environmental, community, finance, and land acquisition) from plant, conveyance, and outfall design teams, along with input from local jurisdictions. The Level 3 screening process will be performed during engineering predesign after the Final EIS is issued.

# 1.0 Background/Introduction

# 1.1 Project Description

King County has prepared a Draft Environmental Impact Statement (Draft EIS) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall and associated conveyances.

The County Executive authorized the preparation of a set of Technical Reports, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state and local permitting requirements.

Thus, the readers of this Technical Report should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

# 1.2 Objective

The objective of this Technical Memorandum is to evaluate potential construction methods for the installation of the outfall pipeline(s) through the nearshore, which is the area beginning at the shoreline and extending to water depths of up to 80 feet. Construction alternatives evaluated in this Technical Memorandum include trenchless and open-trench methods developed based, in part, on input from technical advisors gathered during workshops held by King County and the Marine Outfall Siting Study Project Team in early 2002. Nearshore construction alternatives and their associated risks were summarized in the *Nearshore Risk Analysis Technical Report* (King County, 2002c). The evaluation presented in this Technical Memorandum includes additional technical advisor input based on findings presented in the *Brightwater Marine Outfall Conceptual Design Report* (Parametrix, 2002a) and the Draft EIS (King County, 2002b). These documents contain updated information regarding the overall Brightwater project description, along with more detailed outfall predesign analyses that were not available to the advisors at the

time of the 2002 workshops. The reader is referred to the above-mentioned documents for a full description of the Brightwater System and the current level of outfall design.

Potential outfall locations, called zones, presented in the Draft EIS include Zone 6 for treatment plant construction at the Unocal site and Zone 7S for treatment plant construction at the Route 9 site. Nearshore construction alternatives are evaluated in this Technical Memorandum for both outfall Zones 6 and 7S. Other design and construction details, such as the number of pipelines (Pending), pipeline material and size (Pending), and the diffuser location and configuration (King County, 2003b), are the subject of separate Outfall Technical Memoranda.

In general, trench construction is less costly than trenchless construction. However, at the current level of design, it is difficult to accurately identify significant cost differences. Thus, cost considerations are not utilized in this Technical Memorandum to compare the relative benefits of either construction method. Outfall cost estimates based on predesign engineering analyses will be developed in support of the preferred Brightwater System selected after issuance of the Final EIS.

## 1.3 Construction Alternatives Summary

Construction activities for an outfall in Zone 6 could originate from a proposed staging area located near the Brightwater Wastewater Plant site effluent pump station located on the proposed Unocal plant site. The proposed location of the pump station is shown on the preliminary plant site layout in Figure 1 (located at the end of this document). Construction activities for an outfall in Zone 7S would originate from the staging area at Portal 19. The preferred area for Portal 19 is identified as Parcels C in Figure 2 (located at the end of this document), this staging areas will be the western terminus of the effluent conveyance pipeline.

Construction activities in support of the outfall are anticipated to be similar for staging areas at both Zones 6 and 7S. From the staging area, the outfall pipeline could proceed toward the shoreline and through the nearshore by means of open-trench and/or trenchless construction.

In general, a relatively flat shelf where environmental resources are most dense extends approximately 500 to 2,000 feet offshore.<sup>2</sup> For the purposes of this document, the nearshore shall be defined as this gently sloping area beginning at the shoreline and extending to water depths up to 80 feet (–80 feet Mean Lower Low Water [MLLW]). Within Zone 6, the nearshore outfall segment length is approximately 950 feet. Depending on the alignment, the nearshore outfall segment length in Zone 7S is between 700 and 2,000 feet. Onshore construction may be required for both zones. Construction beyond the nearshore is not evaluated in this Technical Memorandum.

<sup>&</sup>lt;sup>2</sup> Plant and animal species likely to be present in the nearshore habitat areas are identified in the *Phase 2 Biological Resources Report* (King County, 2001a) and *Phase 3 Biological Resources Report* (King County, 2002d).

### 1.3.1 Nearshore Construction Methods - Open Trenching

Open-trench construction could begin from a land-based staging area, extend on land to the shoreline, and then continue in water through the nearshore. The length of the trenched segment would depend on site-specific topography and ground conditions determined during predesign and final design. This method of construction within the nearshore involves excavating a trench, placing bedding and the pipeline in the trench, backfilling, armoring the pipeline, if necessary, and restoring the ground surface. The in-water construction activities can be performed either by equipment operating from barges or from a temporary trestle pier that could extend into the water from the shoreline as excavation and pipeline installation progresses. The construction method selected would depend on water depth, land access, and contractor preference and experience. Both barge and trestle installation methods would likely utilize trench sheeting in which large interlocking metal "sheets," called sheet piles, would be driven into the seafloor to minimize the trench width and disturbance to the nearshore habitat.

#### 1.3.2 Nearshore Construction Methods – Trenchless

Trenchless construction through the nearshore could be accomplished by *conventional tunneling*, *microtunneling*, or by *horizontal directional drilling* methods<sup>3</sup> (hereafter, HDD).

Conventional tunnel construction could utilize the same tunnel boring machine (TBM) used to install the land-based conveyance pipeline.<sup>4</sup> The conveyance tunnel could continue under the nearshore and terminate at a vertical riser structure. Description of conventional tunneling methods and selection of the alternative tunnel portal locations are discussed in Conveyance Team Technical Memoranda and are beyond the scope of this Technical Memorandum.

Microtunnel construction could begin from the proposed conveyance tunnel terminus portal (Zone 7S) or from the proposed effluent pump station (Zone 6) and extend under the nearshore area. Microtunnel construction would terminate near the seafloor at a prefabricated receiving structure excavated into the seafloor side slope as discussed in Section 2.5. Microtunnel alignments could terminate at water depths up to –60 feet MLLW depending on site-specific topography, ground conditions, and location of aquatic vegetation determined during predesign and final design.

As noted above, current HDD technology is not viable for installation of a single outfall pipeline of the size required for the anticipated Brightwater System flows. Use of HDD methods would necessitate installation of dual pipelines, which may be cost prohibitive. If considered feasible, HDD construction would be launched from the ground surface at a staging area located adjacent

Nearshore Alignment and Cosntruction Method Alternatives

<sup>&</sup>lt;sup>3</sup> At the time of the Nearshore Risk Analysis Workshop (February 2002), Larry Bertolucci, VP of Engineering, Cherington Corporation, Sacramento, California, indicated that current technology for horizontal directional drilling would require dual pipeline installation to convey the anticipated Brightwater System flows. However, he emphasized that ongoing technology development could make directional drilling a viable method for a single pipeline by the time the outfall is permitted and constructed, 2 to 8 years from now.

<sup>&</sup>lt;sup>4</sup> As of the date of this Technical Memorandum, tunnel bore diameter proposed for the conveyance tunnel at the Unocal site and at Portal Siting Area 19 are 16 feet and 12 feet (outside diameter), respectively.

to the conveyance tunnel terminus portal or at some other location nearer to the shoreline. Although an offshore shaft may not be required, HDD installation methods would require that in-water equipment be located at the tunnel terminus.

A schematic view of potential conventional, microtunnel, and HDD profiles is presented in Figure 4 (located at the end of this document).

## 1.4 Outfall Alignment Alternatives

Alternative outfall alignments for Zone 6 (Figure 5 located at the end of this document) and Zone 7S (Figure 6 located at the end of this document) were developed during the conceptual design phase. These alignments differ based on outfall zone specific data, potential locations of the conveyance pipeline terminus, and the method of nearshore outfall pipeline installation. Both open-trench and trenchless construction methods were evaluated for the nearshore segment of each alignment.

The proposed alignments and nearshore construction methods are intended to be representative of the range of possible alignments that the final constructed outfall could follow. The exact alignment of the outfall pipeline will be determined based on site-specific marine surveys, geotechnical exploration, and further engineering analysis during predesign and final design.

## 2.0 Trenchless Construction Methods

#### 2.1 General Introduction

The methods and sequence of construction for the three trenchless techniques vary significantly and are discussed in Sections 2.2, 2.3, and 2.4. Common considerations are addressed in Sections 2.1.1 and 2.1.2. As discussed herein, trenchless methods are applicable to construction through the nearshore. All trenchless methods could terminate either with or without an offshore portal.

Pipeline construction beyond the nearshore would begin from the terminus of the nearshore construction and utilize offshore construction methods (segmental lay, controlled submergence, or bottom pull) as discussed in the *Brightwater Marine Outfall Conceptual Design Report* (Parametrix, 2002a).

#### 2.1.1 Geotechnical Considerations

The ground conditions likely to be encountered along the alignment may impact the trenchless construction methods. Based on the preliminary geotechnical borings, geophysical surveys, and historical site data, subsurface soils likely consist of peat; silts; sands; and deep glacial marine sands, silts, and clays. Each trenchless construction method alterative is applicable for use in the subsurface glacial soils likely to be encountered and is capable of balancing pressure within the tunnel to maintain a stable tunnel face and prevent the inflow of water at the water depths proposed.

Physical barriers, such as boulders, old support piles, or logs and trees buried beneath the seafloor can impact the success of construction for any of the trenchless methods. The presence of physical barriers along the outfall alignment may necessitate abandonment of the microtunnel alignment or excavation of a shaft to remove the barrier or provide access to the boring machine face. The preliminary borings and geophysical surveys completed during conceptual design did not detect subsurface conditions that would prohibit the use of trenchless construction methods. However, potential barriers to trenchless construction are often anomalies in the subsurface conditions and only detected during construction. Subsurface anomalies occur relatively frequently in the Puget Sound and have created significant difficulties for many trenchless projects.

It cannot be overemphasized that tunneling has inherent risks different from those of open-trench construction. Tunnel equipment is subject to mechanical breakdown and difficulty of advancement if logs or boulders are encountered as described in the previous paragraph. Should these conditions require access to the tunnel head from the exterior of the tunnel, the habitat areas driving the selection of tunneling for nearshore construction could be damaged in a manner similar to that which would occur with open-trench construction.

Continuing geotechnical borings and geophysical surveys along the outfall alignments will provide more information concerning subsurface barriers and the characteristics of the soils. Results of geotechnical and geophysical investigations will likely be available in late 2003. Analysis based on the results of these borings and surveys must be considered as part of any further evaluation of tunnel construction methods. As noted above, the planned geotechnical explorations will not completely eliminate the risk associated with trenchless construction methods.

## 2.1.2 Drilling Fluid (Slurry)

Microtunneling, HDD, and in some instances, conventional tunneling methods use drilling fluid to resist soil and groundwater pressures at the excavation face, and facilitate the excavation and spoils removal process. Drilling fluids also serve the purpose of reducing wear on the cutting face of the tunnel equipment, improving stability of the tunnel, transporting excavated material from the cutting face, controlling groundwater inflow, and/or providing lubrication for pipeline installation. The drilling fluids most commonly used in microtunneling and directional drill applications are comprised of water, bentonite (a naturally occurring clay), and/or synthetic polymers to enhance the plasticity of the fluid.

The drilling fluid is pumped into the excavation and transported back to the surface along with excavated cuttings suspended within the fluid. The fluid/spoils mixture is referred to as a slurry. Slurry is typically cleaned and recirculated (recycled) into the excavation as the tunnel equipment advances. Slurry recycling equipment typically includes shaking sieves or other screening devices to remove coarse particles. Additional spoils removal is achieved with various sized cyclone equipment that separates smaller particles from the drilling fluid.

# 2.2 Conventional Tunneling

Tunnel construction under the nearshore includes launching of the tunneling machine from a portal, advancement of the tunnel machine, removal of excavated material, installation of the pipeline, and retrieval of the tunneling equipment. These construction activities would be supported from within the excavated tunnel, from within the tunnel launch portal, and by various activities adjacent to the portal on the ground surface.

As identified in Section 1.3.2, conventional tunneling may continue beyond the shoreline and terminate at an offshore location. Construction of an offshore portal may occur either before or after completion of the tunnel. While conventional tunneling is considered an acceptable technology to advance through the nearshore, terminating the conveyance tunnel within the nearshore is not considered an acceptable alternative for the Conveyance Team. Portal construction in the nearshore would have construction and operation disadvantages as compared to construction onshore at either the Unocal site or Portal Siting Area 19. Placement of the portal in the nearshore would negatively impact the preferred location of conveyance structures and facilities and would create access difficulties for operation and maintenance activities. Due to conveyance system construction and operation disadvantages, conventional tunnel construction methods are not considered a viable construction alternative.

## 2.3 Microtunneling

#### 2.3.1 General

Microtunneling is a remotely controlled method of construction, which does not require personnel within the tunneling machine. The equipment is controlled from outside of the tunnel. Remote operation provides control for direction and elevation of the bore, with the advancement of the microtunneling machine and concurrent removal of spoils. The microtunneling machine is comprised of a cutting face, pressurized chamber, and steering jacks that are located within a protective shield. Hydraulic jacks located within the tunnel access portal push against a jacking frame or the backside of the tunnel access portal to move both the pipe and tunneling machine away from the access portal. As the hydraulic jacks reach their maximum displacement, the jacks are withdrawn and another pipe section is set into position. The new section is pushed forward and the process is repeated for the entire length of the tunnel.

## 2.3.2 Staging Area/Equipment Requirements and Description

Microtunneling would require a portal onshore. This portal, often referred to as a launch pit, would be approximately 10 to 15 feet wide by 20 to 40 feet long and up to 40 feet deep to provide sufficient space for the microtunneling and jacking equipment.

If construction schedules allow, it is likely that the proposed final conveyance tunnel portal at proposed Portal Siting Area 19 could be used as a launch pit for the outfall microtunnel. Portals and the surrounding work area (staging area) act as the focal point for tunnel construction activities; including equipment access to the tunnel, exit point for spoils and equipment, slurry mixing and processing equipment, and project support and management activities. Examples of

a microtunneling site layout at a staging area are shown in Figure 7 (located at the end of this document).

Microtunnel construction may terminate either at a constructed trench face or at an offshore access shaft. Microtunnel terminus strategies are discussed in Section 2.5.

#### 2.3.3 Method Description

During microtunneling, soil is excavated by a rotating cutting head. Based on current understanding of site geology, a microtunnel machine used to install the nearshore pipeline would be required to control hydrostatic head imposed on the excavation face by groundwater. Hydrostatic head would be controlled by pressurizing the slurry at the front of the microtunnel boring machine (MTBM).

The MTBM is supported by several inter-related components including the jacking/propulsion, spoils removal, guidance, and lubrication systems. The pipeline is propelled forward from the launch shaft by a group of large hydraulic jacks pushing against a jacking frame or the rear of the launch pit. Required jacking force (capacity) is determined by the length and diameter of the bore as well as the characteristics of the soil. Soil resistances are generated from the face pressure and friction along the length of pipeline. The maximum distance that a pipe can be driven from the launch pit is approximately 2,500 feet, with a typical distance of approximately 800 to 1,200 feet.

The spoils removal system consists of a closed loop recirculation of drilling fluid mixed at the surface staging area. The drilling fluid is pumped through a pipe to the mixing chamber at the MTBM face. The excavated spoils are mixed with the slurry and continuously pumped out of the chamber and back to the surface. At the surface, the spoils/slurry mixture is processed to remove the spoils as discussed in Section 2.1.2.

Continuous monitoring of the achieved grade and alignment of the tunnel is typically achieved by laser surveys. Any corrections are made through the steering jacks in the MTBM. Both the lasers and steering jacks are operated from a control facility at the ground surface.

Slurry used at the cutting face to control hydrostatic pressures may potentially migrate toward Puget Sound waters through subsurface cracks and seams. The potential for slurry migration increases as the tunnel machine nears the seafloor. Since microtunnel construction would use the slurry at a fairly low pressure, the amount of slurry migration is anticipated to be fairly small. Slurries contain naturally occurring and/or nonhazardous materials and would not be expected to have significant environmental impacts. However, due to its specific gravity, any slurry released during tunneling construction would settle out in the water column to the seafloor. If the deposition of the slurry was sufficiently deep, benthic organims could potentially be smothered prior to the dispersion of the slurry by prevailing currents.

#### 2.3.4 Method Characteristics and Limitations

Impassable barriers may necessitate abandonment of the microtunnel alignment or excavation of a shaft to remove the barrier or provide access to the boring machine face. Should an access shaft be required, habitat areas that were avoided by the selection of tunneling for nearshore

construction could be impacted in a manner similar to that which would occur with open-trench construction

The most common range of pipe diameter for microtunneling methods is from 24 to 96 inches. Microtunnels can routinely be driven up to 1,200 feet, with a maximum near 2,500 feet. Intermediate jacking systems can be installed along the pipeline to increase the drive distance from the drive shaft.

Many pipeline materials are applicable to microtunneling methods. The most common materials used are steel, reinforced concrete, and glass-fiber reinforced plastic (HOBAS pipe).

Adequate working space is required at the launch pit to accommodate the required pipeline, jacking, and tunnel boring equipment. The space requirement for the drive shaft is determined by the diameter of pipeline and can range from 20 to 40 feet in length. Required staging area space at the surface could be as shown in Figure 7 (located at the end of this document).

There is a wide range of cutter heads available that provide the capability to handle a range of soil conditions, including boulders.

## 2.4 Directional Drilling

#### 2.4.1 General

Horizontal directional drilling (HDD) is a remotely controlled trenchless construction method, which involves three distinct phases. During the first phase, a pilot bore would be drilled the entire length of the desired alignment. The second phase involves the systematic enlargement of the pilot bore by a reamer pulled in reverse to the direction the pilot bore was drilled. During drilling and reaming, drilling fluid is pumped into the excavation at high pressure to fill the void created by the bore, transport the excavated spoils out of the bore, and to prevent collapse of the boring prior to pipeline installation. The fluid and spoils mixture is collected in return pits where it is pumped to machinery to separate spoils from the drilling fluid. These pits vary in size depending on pumping rates, but typically have a volume of at least 500 cubic feet. The third stage includes the installation of the pipeline into the reamed pilot hole during the final pass of the reamer.

# 2.4.2 Current Limitations of Directional Drilling Technology

The limiting factor for HDD construction is associated with the thrust required to overcome frictional resistance during "pullback" of the pipeline through the pilot bore. Frictional resistance is dependent upon the soil characteristics and the length of the pipeline installation. Based on current Brightwater flow estimates and the diameter of pipe that can be installed using HDD technology currently available, dual pipelines would be required. Due to the increased construction costs associated with dual pipe design, HDD pipeline installation is not currently considered a viable construction alternative.

The pipeline material must allow the pipeline to be joined together such that it can accept the sufficient axial tensile forces created as it is pulled through the bore hole. Steel pipe and high-density polyethylene (HDPE) pipe are the most common pipe material presently used in HDD.

The horizontal directional operation requires a working area at the land-based side of the installation that is reasonably level, firm, and suitable for the movement of rubber-tire vehicles. A suitable access road should be provided. Offshore, where the drilling is terminated, equipment (typically barge-mounted) and space is required so that the complete string of pipeline can be fabricated and aligned with the proposed bore hole.

## 2.5 Tunnel Terminus Strategies

Microtunnel construction will require a termination point beyond the nearshore to connect to the offshore outfall pipeline. Termination would involve connecting the subsurface microtunnel to the surface pipeline at a water depth up to –60 feet MLLW. The location of the terminus point would depend on site-specific topography, ground conditions, and the location of aquatic vegetation determined during predesign and final design. A stable exit point would be required to prevent loss or subsidence of cover between the top of the MTBM and the seafloor. In general, microtunnel construction can be performed with minimal risk of slurry loss to the environment or subsidence at the surface when the depth of cover is maintained at or above twice the outside tunnel diameter (10 feet or greater).

A prefabricated receiving structure could be constructed prior to completion of the tunnel alignment that would provide a stable exit point for the MTBM at water depths up to –60 feet MLLW. The structure would likely be installed by driving sheet piles into the seafloor at the exit point as shown in Figure 8. The sheet piles would maintain the stability of the excavation and reduce excavation and backfill volumes at the exit point. Grout would be injected near the sheet pile wall to harden the soils where the MTBM would enter the terminus structure. After the MTBM excavates through the grouted area, the tunnel machine would be retrieved and a temporary cap installed until such time as a connection is made for the remaining pipeline segments. The sheet piles would be removed after completion of the tunnel terminus. Beyond the tunnel terminus point, the outfall pipeline would be installed in a short (up to 200 feet) opentrench until the pipeline reaches the seafloor surface.

# 3.0 Open Trench Construction Methods

#### 3.1 General Introduction

Open-trench construction through the nearshore includes excavation of the trench, pipeline installation, trench backfilling and pipeline protection, and restoration of the trench surface. If required, trench shoring can also be installed ahead of the trench excavation to minimize the extent of damage to the seafloor along the trench alignment. These construction activities can be performed either by equipment operating from barges or from a temporary pier, called a trestle, that could extend into the water from the shoreline as excavation and pipeline installation progresses.

Since the construction methods and equipment used for both barge-mounted and trestle pipeline installation are very similar, the following discussion can be applied to both methods. Differences in construction activities or equipment between the methods are identified and discussed.

Pipeline construction beyond the nearshore would begin from the terminus of the nearshore construction and utilize offshore construction methods (segmental lay, controlled submergence, or bottom pull) as discussed in the *Brightwater Marine Outfall Conceptual Design Report* (Parametrix, 2002a).

#### 3.2 Geotechnical Considerations

As identified by preliminary geotechnical and geophysical explorations, open-cut or sheet pile trench construction through the nearshore will generally encounter loose to compact granular soils to the depth of the required excavation (approximately 15 feet). These materials should not present any unusual or difficult construction problems for trench excavation. The composition and density of the materials will impact the stability of open-cut slopes and the width of the excavation section. In addition, sediment control may be required if fine-grained soils are encountered.

The preliminary data<sup>5</sup> has identified some areas of cobbles and boulders in shallow water of Zone 7S that could impact the installation of sheet piles. These conditions could increase the construction costs due to the difficulty or the need to remove obstructions. To the extent feasible, the sheet pile section should be located in areas of minimal cobbles and boulders.

Continuing geotechnical borings and geophysical surveys along the outfall alignments will provide more information concerning the characteristics of the soils and potential stability issues. Results of geotechnical and geophysical investigations will likely be available in late 2003.

## 3.3 Staging Area

A land-based staging area located near the proposed conveyance tunnel terminus (Zone 7S) or proposed effluent pump station (Zone 6) would be required if trestle construction were utilized to excavate the nearshore trench. Materials and supplies could be transported between the staging area and trestle along a conveyor system. Barge-mounted construction activities may also use a land-based staging area. However, it is most likely that trench excavation and pipeline installation would be supported offshore via supply and storage barges.

Activities at the land-based staging area, utilized at the contractor's option, could include assembly of pipeline structures, loading and unloading of trucks carrying materials, storage of construction materials, and storage of construction machinery such as trucks, cranes, and backhoes. The staging area could also hold construction offices for King County and contractor personnel. The staging area could be in use for the duration of onshore, nearshore, and offshore construction

# 3.4 Trench Sheeting

Sheet piles can be utilized to minimize environmental impacts to nearshore habitat. The sheets are driven into the seafloor to minimize trench section width and prevent surrounding soil and sediment from sloughing into the trench during excavation. Trench sheeting would extend above

<sup>&</sup>lt;sup>5</sup> Preliminary geotechnical data was collected from within the respective outfall zones, but is not alignment-specific.

the seafloor and could, at the contractor's option, extend to or above the water surface. This extension to the water surface makes the trench more visible and should lessen the time required for construction. The presence of the materials above water should not interrupt marine traffic. After pipe installation and backfill, the trench sheets would be removed.

The most common types of equipment used to install sheet pile walls are vibratory hammers and impact hammers, both of which could be used on barges as well as a trestle. Vibratory hammers are widely used because they usually can drive the piles faster, do not damage the top of the pile, and can easily be extracted.

Unsheeted trench installation could disturb a width of 60 to 100 feet along the length of the pipeline. Sheeted trench installation could reduce the seabed impact to approximately a width of 20 to 25 feet along the length of the pipeline. See Figure 9 (located at the end of this document) for cross-sections of sheeted and unsheeted trench construction.

## 3.5 Barges

Barge supported trench excavation would require a "working barge" along with several support barges. Tugboats would be used for moving barges to and from the site and for positioning of the working barge. The working barge would be equipped with a crane for laying pipeline segments and excavating the trench. The support barges would be used to supply the working barge with pipeline segments and backfill material while additional barges could store excavated soils for use as backfill or transport to the disposal site.

The working barge could be anchored to the seafloor with "spuds." Spuds act like pins sticking into the seafloor below the barge and can be used up to water depths of –60 feet. Spuds can be raised and lowered to allow movement of the working barge. Typically the barge could be pushed into shallow water by working tugs. Two anchors would be placed offshore to allow positioning "pull." The spuds are then utilized to allow control of the angular position of the barge relative to the trench direction. Since the spuds move up and down vertically from the barge, no additional footprint space would be required. However, the spuds could cause additional damage to the seafloor itself. Penetration of the spuds into the seafloor may reach 3 or 4 feet, depending on soil conditions. For barges supplying the working barge, or for barges working beyond water depths of 60 feet, four to six anchor lines could be used. Anchor lines extend from the barge in several directions and are typically up to 1,000 feet long.

# 3.6 Excavation Equipment

The excavation of a pipeline trench would likely be performed using mechanical excavation equipment. Mechanical excavators, such as clamshell type equipment, are the most common types of equipment used in marine excavation and pipe laying applications. Mechanical equipment can be mounted on a trestle or barges and can be used successfully with both hard and soft materials

Selection of the type of equipment used to perform the excavation will depend on the following factors:

- Physical properties of the excavated material.
- Quantities of material to be excavated.
- Distance for transport to the disposal area.
- Presence and concentration of contamination (meet PSDDA requirements).
- Equipment readily available to contractors.
- Cost.
- Turbidity impacts.

## 3.7 Excavated Material Storage and Transportation

Barges, used in conjunction with mechanical excavation equipment, have been the most widely used methods of transporting large quantities of excavated material in the Puget Sound. Barges could also be the most likely means of storing excavated material that would be utilized for backfill of the pipeline, once installed. Based on very limited information concerning the specific bottom soil properties, it is anticipated that the native material to be excavated could be suitable for a portion of the backfill, assuming its use would conform to regulatory requirements. Disposal of excavated material offsite will be required since at least some of the excavated material will be in excess of that necessary for backfill.

## 3.7.1 Open Water Disposal

The most viable method of excavated marine soil disposal is that allowed in open water. All disposal of soils is regulated by the United States Army Corps of Engineers (COE) and must occur at regulated disposal sites. The exact location of the disposal site will be determined through the permitting process. Materials must meet contamination levels below those promulgated by the Puget Sound Dredge Disposal Analysis (PSDDA).

## 3.7.2 Upland Disposal

If open-water disposal were not feasible, excavated soils could be disposed of on land at regulated landfill sites. The landfill site would be selected based on the presence, if any, and concentration of contaminants in the excavated soils. Due to increased land disposal costs, upland disposal should not be considered as the primary option.

# 3.8 Bedding and Pipe Protection

Subject to permit limitations, native material may be suitable for backfill of the trench above the bedding and armoring zone. Armoring of the pipeline may be necessary in water depths up to approximately –50 feet MLLW. Armoring is provided to protect the pipeline from wave action, erosion, and anchor damage by both small boats and larger vessels, as appropriate. The selected bedding and armoring material would be specified based on full consideration of the nature of existing soils, current conditions, and historical evidence of erosion. A crushed material without

fines is the material most likely to be specified so as to provide a good base while limiting the material that could cause turbidity issues upon placement in the water. Imported materials for the pipe bedding zone could be placed by clamshell. Pipeline armoring material could be similarly placed.

#### 3.9 Method Characteristics and Limitations

Trench construction and pipeline installation can be utilized for all of the Brightwater outfall pipeline diameter and material alternatives. Trench construction is not limited in terms of the nearshore segment length.

Staging area and access requirements for trench construction are similar, but likely not as large as for tunnel construction. Adequate space for storage of pipeline segments, backfill material, and excavated material is available at any of the potential conveyance tunnel terminus areas. If access were limited, trench excavation and pipeline installation could be supported from the water by several barges.

Surface and subsurface soil properties should not have a significant impact on trench excavation. Mechanical excavation equipment is suitable for both hard and soft materials. The presence of boulders along the nearshore outfall segment may impact installation of sheet piles.

# 4.0 Outfall Construction and Alignment Alternatives

Construction alternatives and alignments originating from the effluent pump station at the Unocal plant site and the land-based conveyance tunnel terminus at Portal Siting Area 19 were developed based on input from technical advisors and additional engineering analysis. Potential staging areas within Portal Siting Area 19, as shown in Figure 2 (located at the end of this document), include Parcel A (Upper Point Wells), Parcel C (Lower Point Wells), and Parcel E (Richmond Beach). The analysis in this section includes alignments and construction alternatives for each of the potential staging areas within Portal Siting Area 19, as well as for outfall construction from the Unocal plant site.

The alignments described in this section have been evaluated with the knowledge that unknown site features may significantly impact outfall construction. Trench construction through the nearshore is the predominant method of outfall installation in Puget Sound and is less sensitive to unknown site features than microtunnel construction.

# 4.1 Proposed Richmond Beach Alignments

The proposed Richmond Beach site is owned by King County and may require fewer easements for outfall construction staging and facilities (temporary or permanent). Outfall alignments originating from the proposed Richmond Beach site alternative would have minimum impact on shipping activities at the Chevron Facility. Both tunnel and trench alignments would likely follow the same pipeline route and would cross under the Burlington Northern Sante Fe (BNSF) Railroad located between the land-based conveyance tunnel terminus and the shoreline.

A broad area of the dense nearshore habitat extends up to 2,000 feet into Puget Sound from the shoreline near the Richmond Beach site alternative (Parcel E). All alignments originating from the proposed Richmond Beach site would be required to cross through or under this habitat area.

## 4.1.1 Proposed Richmond Beach Microtunnel Alternative

Excavation and pipeline installation along the proposed Richmond Beach microtunnel alignment would extend up to approximately 1,800 feet from the conveyance tunnel terminus to the microtunnel exit point. The tunnel would be excavated approximately 20 feet below the seafloor to a water depth between –40 to –60 feet MLLW. Selection of the microtunnel terminus point would depend on site-specific topography, ground conditions, and the location of aquatic vegetation determined during predesign and final design. The microtunnel would terminate at a prefabricated receiving structure approximately 20 feet below the existing seafloor as described in Section 2.5.

The length of the Richmond Beach microtunnel alignment (1,800 feet), especially at the required Brightwater outfall diameter, would be at the upper limit of current microtunnel technology. Although microtunnel construction would avoid large areas of dense nearshore habitat, there is a potential that one or more access shafts may need to be excavated along the alignment due to the length of the segment and the potential to encounter impassible barriers (see Section 2.1.1). Excavation of these access shafts would significantly increase construction costs, construction duration, and could potentially create significant environmental impacts.

Use of microtunnel construction may release drilling fluid to the environment. Risk of fluid loss increases as ground cover above the MTBM decreases. Microtunneling would likely terminate when ground cover is between 12 and 20 feet. However, the quantity and impact of drilling fluid loss is not anticipated to be significant.

Assuming that no significant construction delays are encountered, the Richmond Beach microtunnel and offshore construction could be completed in one construction season.

## 4.1.2 Proposed Richmond Beach Trench Alternative

Excavation and pipeline installation along the proposed Richmond Beach trench alignment would extend approximately 2,000 feet from the conveyance tunnel terminus to approximately –80 feet MLLW. Trench excavation from Richmond Beach would likely utilize trench sheeting to cross areas of dense nearshore habitat.

Land excavation equipment would be used from the tunnel terminus shaft to the shoreline. A short segment of pipeline would be jacked/bored under the BNSF Railroad. From the shoreline, sheeted trench construction could progress via a barge-mounted crane to approximately –50 feet MLLW. The excavated trench between the sheet piles may be approximately 20 to 25 feet wide and 10 to 15 feet deep. Unsheeted trench excavation (up to 15 feet deep) could continue to approximately –80 feet MLLW. Depending on the sediment characteristics, the unsheeted trench top width could vary between 60 and 100 feet. Access for pipeline construction activities west of the shoreline could primarily be from the waterside with only limited access requirements for a small personnel boat from land.

Between 0 and -20 feet MLLW, construction activity may follow tidal cycles to prevent grounding of construction barges. The area of disturbance would be limited to the working barge width and spud placement on the seabed (approximately a 60-foot-wide path).

Trench construction through the nearshore is the predominant method of outfall installation in Puget Sound. However, the trench alignment originating from Richmond Beach would cross a large area of dense marine habitat. Trench construction could create a large environmental disturbance as compared to the microtunnel construction method. Even with the use of trench sheeting, trench excavation would remove the greatest volume of native soils and may cause greater turbidity impacts.

Construction activity could require multiple shifts (nighttime work) to complete the project in one construction period. Despite multiple shifts, trench construction may require a second construction season if trench sheeting or trestle construction were utilized. In general, trench construction is less costly than tunnel construction. The cost benefits of trench construction may be negated by construction restoration costs or if trench construction activities were to require a second construction season.

## 4.2 Proposed Lower Point Wells Alignments

The proposed Lower Point Wells site alternative (Parcel C) is owned by Chevron USA Inc. All alignments originating from the Point Wells site may be impacted by existing soil and groundwater contamination contained on-site by an existing seawall at the tip of Point Wells. Excavated soils and dewatering from land-based construction may require additional treatment before disposal. Construction methods should be selected based on consideration of the required volume of excavated material and dewatering, as well as the potential for migration of contamination from existing contained location(s).

Construction activities and the use of temporary and/or permanent structures at the proposed Lower Point Wells site alternative will require easements. Construction activities may also require coordination of shipping access at the Chevron dock located at Point Wells. The staging area available at the proposed Lower Point Wells site is larger than is available at Richmond Beach. The larger area could provide greater flexibility in the selection of both nearshore and offshore construction alternatives. The proposed Lower Point Wells site is an existing industrial area, further removed from residents than the proposed Richmond Beach site. Road and water access to the proposed Lower Point Wells site are also favorable.

Trench and tunnel alignments may follow different pipeline routes from the conveyance tunnel portal location in order to avoid areas of dense nearshore habitat located south of Point Wells.

## 4.2.1 Proposed Lower Point Wells Microtunnel Alternative

Excavation and pipeline installation along the proposed Lower Point Wells microtunnel alignment would extend approximately 1,400 feet from the conveyance tunnel terminus to the microtunnel exit point. The tunnel would be excavated approximately 20 feet below the seafloor to a water depth between –40 to –60 feet MLLW. Selection of the microtunnel terminus point would depend upon site-specific topography, ground conditions, and the location of aquatic

vegetation determined during predesign and final design. The microtunnel would terminate at a prefabricated receiving structure approximately 20 feet below the existing seafloor as described in Section 2.5.

The length of the Lower Point Wells microtunnel alignment (1,400 feet), especially at the required Brightwater outfall diameter, would be longer than the routine range of current microtunnel construction, but within technology limits. Although microtunnel construction would avoid large areas of dense nearshore habitat, there is a potential that one or more access shafts may need to be excavated along the alignment due to the length of the segment and the potential to encounter impassible barriers (see Section 2.1.1). Excavation of these access shafts would significantly increase construction costs, construction duration, and could potentially create significant environmental impacts.

Microtunneling could also be used onshore at the proposed Lower Point Wells site to minimize the impact of contamination on construction activities. The amount of soil and groundwater disturbed by microtunneling is less than that for trench construction. The onshore microtunnel alignment would follow a similar pipeline route as described for the trench alignment discussed in Section 4.2.2. Microtunnel construction may breach the contaminant containment provided by the existing seawall and sheeting installed by Chevron. Location and construction details for the sheeting and groundwater containment/treatment system would be required before an onshore microtunnel alignment could be evaluated. These details will be determined during predesign discussion with Chevron.

Use of microtunnel construction may release drilling fluid to the environment. Risk of fluid loss increases as ground cover above the MTBM decreases. Microtunneling would likely terminate when ground cover is between 12 and 20 feet. However, the quantity and impact of drilling fluid loss is not anticipated to be significant.

Assuming that no significant construction delays are encountered, the Lower Point Wells microtunnel and offshore construction could be completed in one construction season.

## 4.2.2 Proposed Lower Point Wells Trench Alternative

Excavation and pipeline installation along the proposed Lower Point Wells trench alignment would extend approximately 1,000 feet from the conveyance tunnel terminus to the tip of Point Wells just south of the existing dock. Onshore trench construction would likely use trench sheeting to minimize the volume of soils excavated from potentially contaminated areas. Construction would take place within the existing seawall up to the tip of Point Wells, where the trench would be constructed through the seawall and would continue approximately 700 feet through the nearshore to a water depth of approximately –80 feet MLLW.

Land excavation equipment would be used from the tunnel terminus shaft to the shoreline. Nearshore trench construction could progress via a barge-mounted crane to approximately -80 feet MLLW. Trench construction through the nearshore may not require sheeting since areas of less dense nearshore habitat have been identified. Depending on the sediment characteristics, the unsheeted trench top width could vary between 60 and 100 feet. Access for

pipeline construction activities west of the shoreline could primarily be from the waterside with only limited access requirements for a small personnel boat from land.

The nearshore area immediately west of the tip of Point Wells increases in water depth very quickly, which allows for favorable water access regardless of the tidal cycle. Areas of less dense environmental resources, identified at the tip of Point Wells, allow greater flexibility for in-water trenching methods. As a result, construction time and cost are likely to be minimized by the Lower Point Wells trench alignment.

Assuming that no significant construction delays are encountered, the Lower Point Wells trench and offshore construction could be completed in one construction season.

# 4.3 Proposed Upper Point Wells Alignments

The proposed Upper Point Wells site alternative (Parcel A) is located on a forested, relatively steep sloped bluff east of Point Wells and the Chevron site. Parcel A is constrained by poor access and is smaller than both the proposed Richmond Beach and Lower Point Wells sites. All potential alignments originating from Parcel A would likely require open-trench construction down the slope toward the shoreline where the pipeline could continue through the nearshore as either a microtunnel or open trench.

Alternative nearshore alignments for the proposed Upper Point Wells site alternative are similar to those presented for construction originating from the proposed Lower Point Wells site. If construction were allowed at the Chevron Facility, both microtunnel and open-trench construction (or a combination thereof) could be utilized as discussed in Section 4.2. Microtunnel construction could be utilized in an alignment south of Point Wells, as discussed in Section 4.2.1, if pipeline construction cannot take place at the Chevron Facility.

# 4.4 Proposed Unocal Plant Site Alignments

Outfall construction at the proposed Unocal plant site would begin from a staging area located near the proposed treatment plant effluent pump station. The proposed location of the pump station is shown on the preliminary plant site layout in Figure 1 (located at the end of this document). All alignments originating from the proposed Unocal site may be impacted by existing soil and groundwater contamination. Excavated soils and dewatering from land-based construction may require additional treatment before disposal.

Construction activities from the effluent pump station to the shoreline would require that the outfall cross under the BNSF Railroad and through the Edmonds Marina Beach area. Outfall construction may also require coordination with the future development and construction of the Edmonds Crossing project.

Staging area at the proposed Unocal site is adequate and would be coordinated with the plant construction schedule. Although staging area for the outfall at the proposed Unocal site would not require additional area within the plant construction site, outfall construction would extend the duration of construction impact to the Edmonds shoreline area.

Trench and tunnel alignments may follow different pipeline routes onshore from the proposed treatment plant effluent pump station location to the shoreline in order to avoid recreational areas along the Edmonds shoreline. Nearshore pipeline routes would be similar for both tunnel and trench construction methods.

### 4.4.1 Proposed Unocal Microtunnel Alternative

Excavation and pipeline installation along the proposed Unocal microtunnel alignment would extend up to approximately 1,500 feet from the proposed treatment plant effluent pump station to the microtunnel exit point. The tunnel would be excavated approximately 20 feet below the seafloor to a water depth between –40 to –60 feet MLLW. Selection of the microtunnel terminus point would depend upon site-specific topography, ground conditions, and the location of aquatic vegetation determined during predesign and final design. The microtunnel would terminate at a prefabricated receiving structure approximately 20 feet below the existing seafloor as described in Section 2.5.

The length of the Unocal microtunnel alignment (1,500 feet), especially at the required Brightwater outfall diameter, would be longer than the routine range of current microtunnel construction, but within technology limits. The absence of densenearshore habitat would make tunneling under the nearshore less advantageous than proven open-trench construction methods. However, microtunnel construction would avoid open-trench impacts to recreational users along the Edmonds shoreline area. Microtunnel construction at the proposed Unocal site would also minimize the impact of contamination on construction activities. The amount of soil and groundwater disturbed by microtunneling is less than that for trench construction. Assuming no subsurface barriers are present, microtunnel construction could reduce the length of the onshore segment since the outfall could be routed directly to the shoreline.

Use of microtunnel construction may release drilling fluid to the environment. Risk of fluid loss increases as ground cover above the MTBM decreases. Microtunneling would likely terminate when ground cover is between 12 and 20 feet. However, the quantity and impact of drilling fluid loss is not anticipated to be significant.

Assuming that no significant construction delays are encountered, the Unocal microtunnel and offshore construction could be completed in one construction season.

### 4.4.2 Proposed Unocal Trench Alternative

Excavation and pipeline installation along the proposed Unocal trench alignment would extend approximately 1,000 feet from the proposed treatment plant effluent pump station location to the shoreline immediately north of the existing Unocal pier. Onshore trench construction would likely use trench sheeting to minimize the volume of soils excavated from potentially contaminated areas. A short segment of pipeline would be jacked/bored under the BNSF Railroad. Onshore trench excavation would be routed to minimize impacts to residential users. This route would be further analyzed as part of continuing predesign and design efforts.

Land excavation equipment would be used from the proposed pump station location to the shoreline. Nearshore trench construction (approximately 950 feet) could progress via a bargemounted crane to approximately –80 feet MLLW. Trench construction through the nearshore

may not require sheeting since areas of less dense nearshore habitat have been identified. Depending on the sediment characteristics, the unsheeted trench top width could vary between 60 and 100 feet. Access for pipeline construction activities west of the shoreline could primarily be from the waterside with only limited access requirements for a small personnel boat from land.

Areas of less dense environmental resources identified in the nearshore allow greater flexibility for in-water trenching methods. As a result, construction time and cost are likely to be minimized by the Unocal trench alignment. Microtunnel construction of certain onshore pipeline segments could provide further advantages along the onshore trench alignment.

Assuming that no significant construction delays are encountered, the Unocal trench and offshore construction could be completed in one construction season.

# 5.0 Summary/Recommendation

As indicated in Section 4, several viable construction methods are available for outfall pipeline installation originating within the proposed Portal Siting Area 19 or from the proposed Unocal plant site. Open-trench construction is a proven construction method for outfall installation in the Puget Sound and is less sensitive to unknown site features than microtunnel construction. Additional predesign and final design analyses will be supported by continuing geotechnical and geophysical explorations, determination of the presence and extent of contamination at the Chevron Facility, and details of the seawall and groundwater containment/treatment system construction at Point Wells.

The factors that impact selection of the nearshore outfall alignment and construction method at Zone 7S include construction risks, staging area characteristics, length of the nearshore outfall segment, environmental resources along the alignment, and the presence and extent of contamination. Each of these factors is discussed below and evaluated for the potential staging areas identified within the proposed Portal Siting Area 19.

Analysis of the nearshore outfall alignment and construction method at Zone 6 is primarily impacted by onshore construction impacts since the staging area would be located at the Unocal plant site. Contamination at the site is well documented. Nearshore habitat and environmental resource areas are less dense.

Preferred alignments and construction methods from staging areas for outfalls in both Zone 6 and Zone 7S are presented in Table 2. These recommendations are based on the current understanding of the site-specific characteristics discussed in this Technical Memorandum.

Table 1.
Preferred Construction Methods

| Staging Area (Outfall Zone) | Onshore Construction | Nearshore Construction |
|-----------------------------|----------------------|------------------------|
| Unocal Plant Site (Zone 6)  | Open Trench          | Open Trench            |
| Richmond Beach (Zone 7S)    | Microtunnel          | Microtunnel            |
| Upper Point Wells (Zone 7S) | Open Trench          | Open Trench            |
| Lower Point Wells (Zone 7S) | Open Trench          | Open Trench            |

#### 5.1 Zone 6 – Outfall Construction

As discussed in Section 4.4, construction activities from the effluent pump station at the proposed Unocal plant site to the Edmonds shoreline would require that the outfall cross under the BNSF Railroad and through the Edmonds Marina Beach area. Outfall construction may also require coordination with the future development and construction of the Edmonds Crossing project.

Microtunnel construction through the nearshore would not provide a significant advantage over more proven open-trench methods due to the relative absence of dense nearshore habitat areas. Microtunnel construction could be utilized to avoid open-trench impacts to the railroad, Edmonds Crossing project, and recreational users. Microtunneling could also minimize construction impact (migration and removal) to known soil and groundwater contamination. However, the potential presence of impassable subsurface barriers could require the excavation of one or more access shafts along the microtunnel alignment, which could result in construction duration and cost increases that would negate the benefits of microtunnel construction.

Based on currently available information, open-trench construction is preferred for installation of the outfall pipeline in Zone 6. Impacts associated with open-trench construction can be more easily mitigated because they are known and can be prepared for in advance. Potential microtunnel impacts are more difficult to prepare for and mitigate due to unknown subsurface conditions.

#### 5.2 Zone 7S – Outfall Construction

#### 5.2.1 Construction Method Risks

Open-trench construction is the predominant construction method for installation of outfall pipelines in the Puget Sound. Although feasible in the ground conditions likely to be encountered, microtunnel construction under Puget Sound has not yet been attempted. Should subsurface conditions, such as impassable barriers, require access to the MTBM from the exterior of the tunnel, habitat areas could be damaged in a manner similar to that which would occur with open-trench construction.

Open-trench construction is less sensitive to unknown site features than microtunnel construction. The impacts associated with open-trench construction can be more easily mitigated because they are known and can be prepared for in advance. Potential microtunnel impacts are more difficult to prepare for and mitigate due to unknown subsurface conditions.

Pipeline alignments from the proposed Lower and Upper Point Wells sites can be routed to avoid broad areas of dense nearshore habitat. Due to the potential risks associated with microtunnel construction and unknown subsurface conditions, open-trench construction is recommended for pipeline installation from these sites. Trench construction would also provide better control over the potential migration of contaminants when the seawall at Point Wells is breached.

Pipeline alignments from the proposed Richmond Beach site would be required to cross through or under a broad area (up to 2,000 feet) of dense nearshore habitat. Due to the anticipated environmental impacts, it is likely that open-trench pipeline installation through this area would include very restrictive permit requirements. Thus, microtunnel construction, despite the potential need for one or more access shafts along the alignment, is recommended for pipeline installation from this site.

#### 5.2.2 Staging Area Characteristics

Staging area characteristics most important to outfall construction include land and water access, size, and location. Land and water access impact the type of construction equipment, material delivery and removal routes, and duration of construction. Each of the sites has adequate space for outfall construction staging. However, the size of the staging area determines the length of outfall pipeline that can be fabricated on site. Larger areas provide more flexibility for both nearshore and offshore construction activities. The location of the staging area, industrial or residential, is directly related to the anticipated construction impacts to the surrounding community. Construction noise and disturbance to the community are proportional to the distance between the staging area and residential areas.

The proposed Lower Point Wells site is located at the existing Chevron industrial site and is further removed from residential areas than the proposed Richmond Beach or Upper Point Wells site alternatives. Area within the Chevron site is also larger, provides better road access, and is less constrained in terms of water access. The nearshore area off the tip of Point Wells is relatively deep, which could allow barge access regardless of the tidal cycle.

Another benefit of the proposed Lower Point Wells site is that it makes the bottom pull pipeline installation method for the offshore outfall segment feasible. Without the greater area available at this location, it is highly unlikely that the bottom pull method could be viable for the proposed Portal Siting Area 19. With greater flexibility available for pipeline installation methods, it is likely that more competitive bids will be submitted for the outfall construction<sup>6</sup>.

<sup>&</sup>lt;sup>6</sup> If microtunnel methods were used to install the nearshore outfall segment, the bottom pull offshore construction method would not be viable.

### 5.2.3 Length of Nearshore Outfall Segment

The length of the nearshore outfall segment directly impacts the construction duration, cost of construction, amount of sediment and soil disturbance, and the risk of weather impacts. Longer nearshore segments may require two construction seasons or continuous (24 hours per day) construction to complete.

Outfall alignments originating from the proposed Richmond Beach site are longer than those from the proposed Lower Point Wells site. Outfall alignments from the proposed Upper Point Wells site would require an additional onshore segment from the staging area to the shoreline. Proposed Point Wells' alignments may utilize land construction techniques that could minimize the amount of in-water work and weather/wave associated risks.

#### 5.2.4 Environmental Resources

As shown in Figure 3 (located at the end of this document), large areas of dense marine habitat are present along the shoreline of Zone 7S. Viable construction methods have been evaluated that could avoid or minimize impacts to these habitat areas. Alternative outfall alignments have also been developed in order to minimize construction impacts. These construction methods and alignments that minimize environmental impact are likely to facilitate the outfall installation permit process and reduce mitigation requirements.

Alternative alignments at the proposed Upper and Lower Point Wells sites can be routed towards the tip of Point Wells to minimize environmental impacts. Alignments originating from Richmond Beach must cross or tunnel under large areas of dense marine habitat.

#### 5.2.5 Presence and Extent of Contamination

Contaminated soils, sediments, and groundwater increase excavation and disposal costs for all construction methods. Construction methods must also be selected to ensure that the contaminant does not migrate from its original location during construction. Contaminated sites often require remediation activities that extend construction duration.

Past industrial activities at the Chevron site may have created areas of soil and groundwater contamination at the proposed staging areas. The presence and extent of potential contamination is yet to be determined. Microtunnel construction methods and activities may reduce the potential for contaminant migration and limit the amount of excavated soils to be treated and disposed. No contamination has been detected at the Richmond Beach site.

#### 5.3 References

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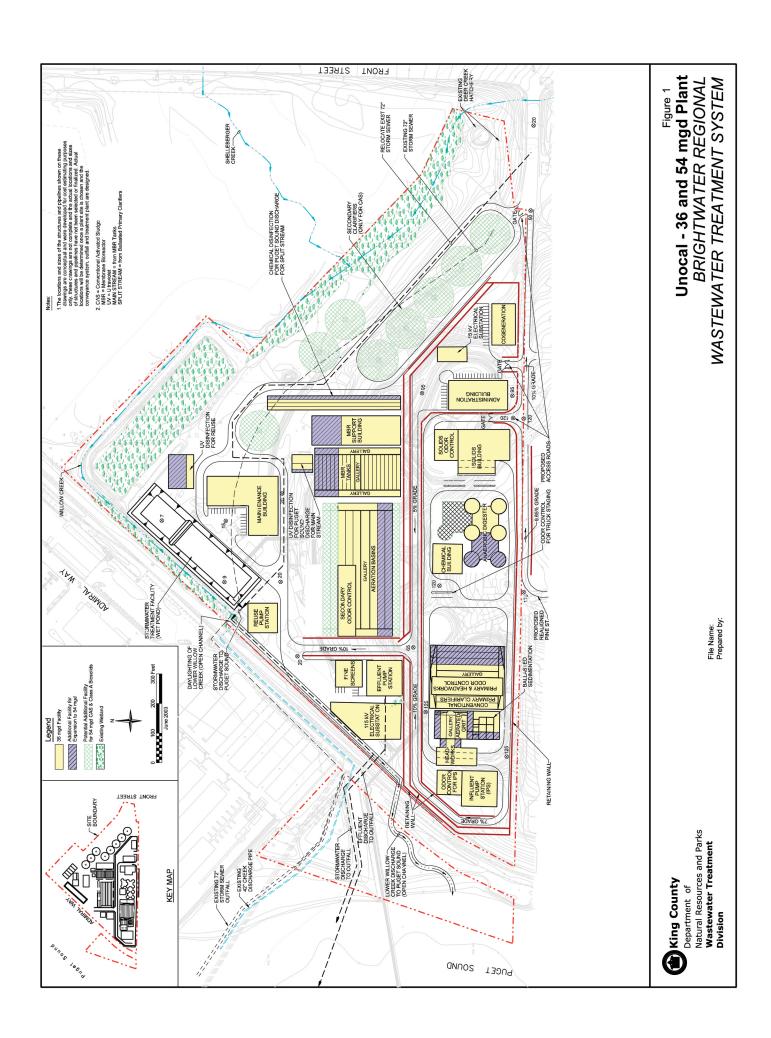
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King County, 2003b. Diffuser Predesign Technical Memorandum. Seattle, Washington.

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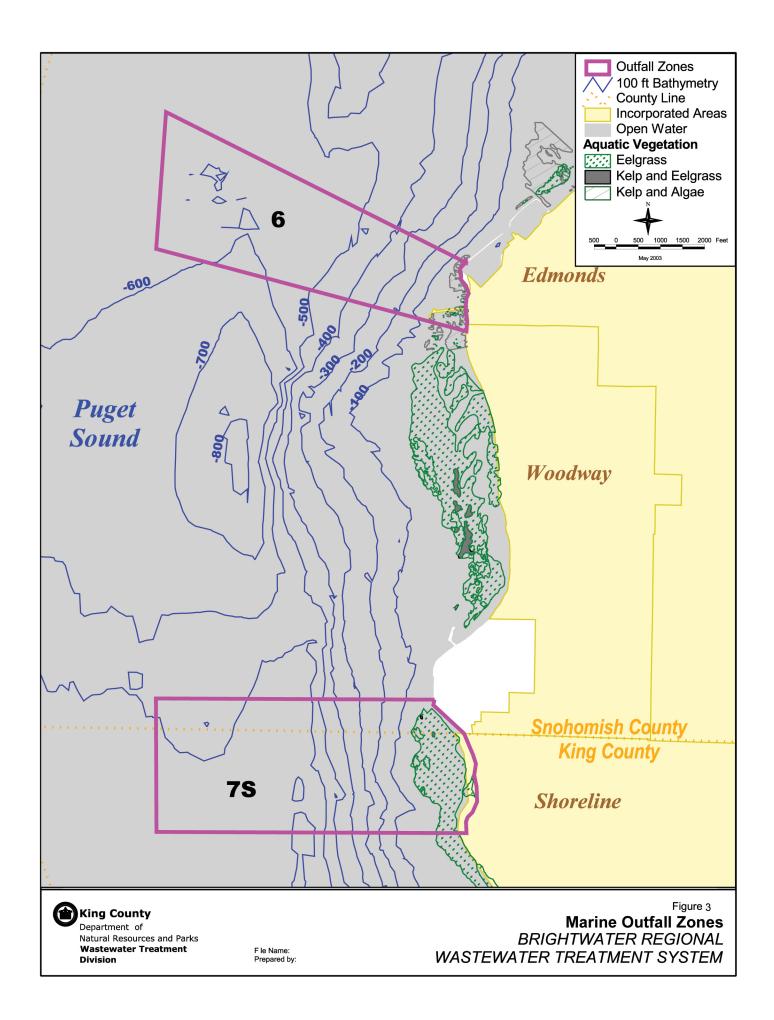


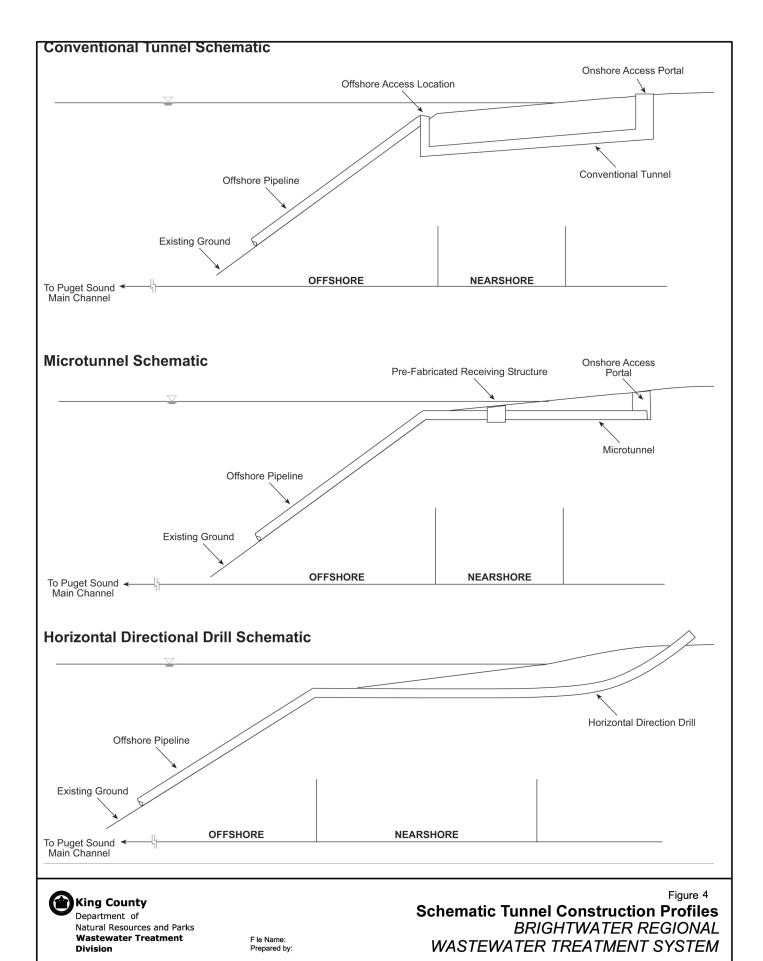
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Natural Resources and Parks
Wastewater Treatment
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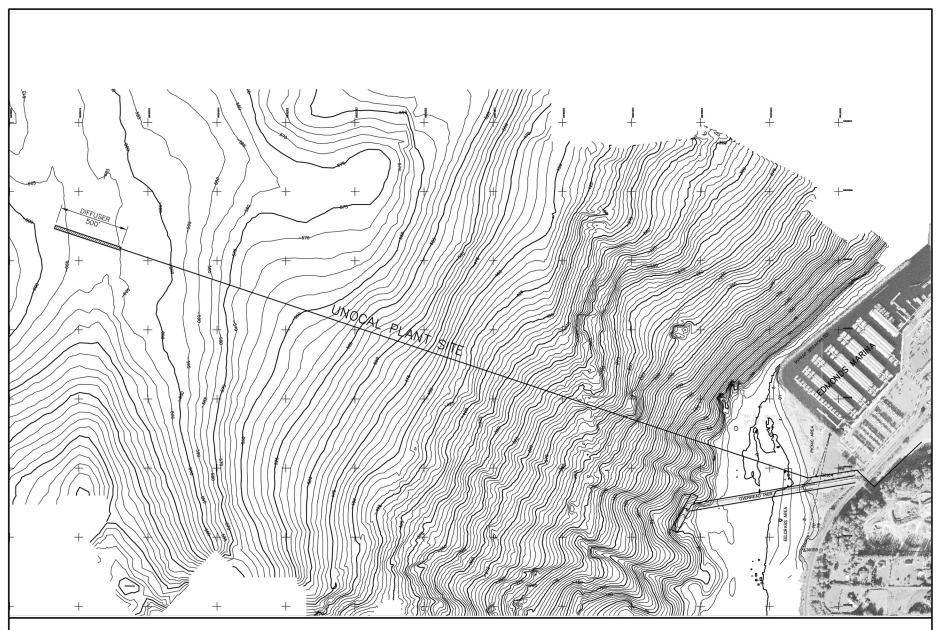
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Portal Siting Area 19 with Candidate Sites

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WASTEWATER TREATMENT SYSTEM



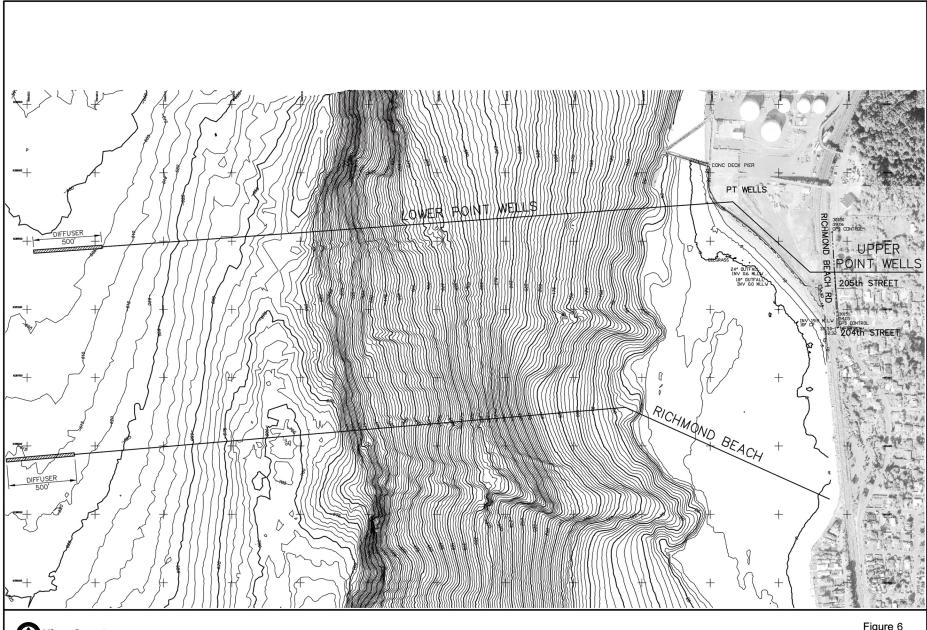




King County
Department of

Natural Resources and Parks Wastewater Treatment Division

File Name: Prepared by: Zone 6 Bathymetry, Alignment, and Diffuser Location
BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM



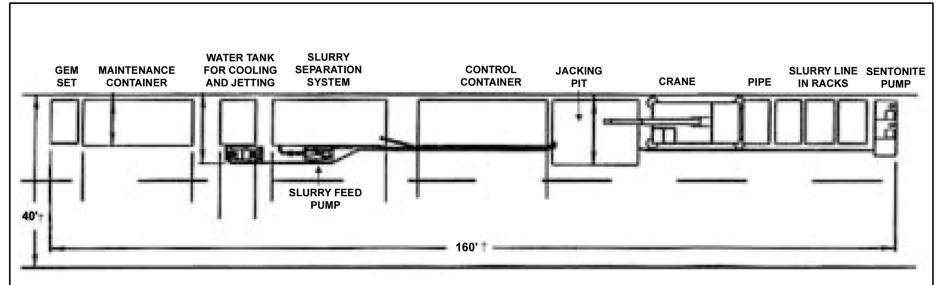
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Division

Zone 7S Bathymetry, Alignment, and Diffuser Location

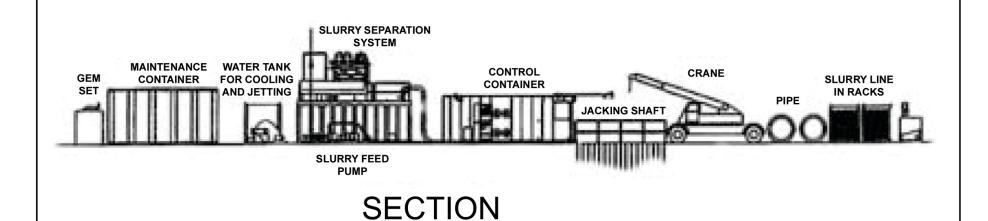
BRIGHTWATER REGIONAL

WASTEWATER TREATMENT SYSTEM

File Name: Prepared by:



# **PLAN**



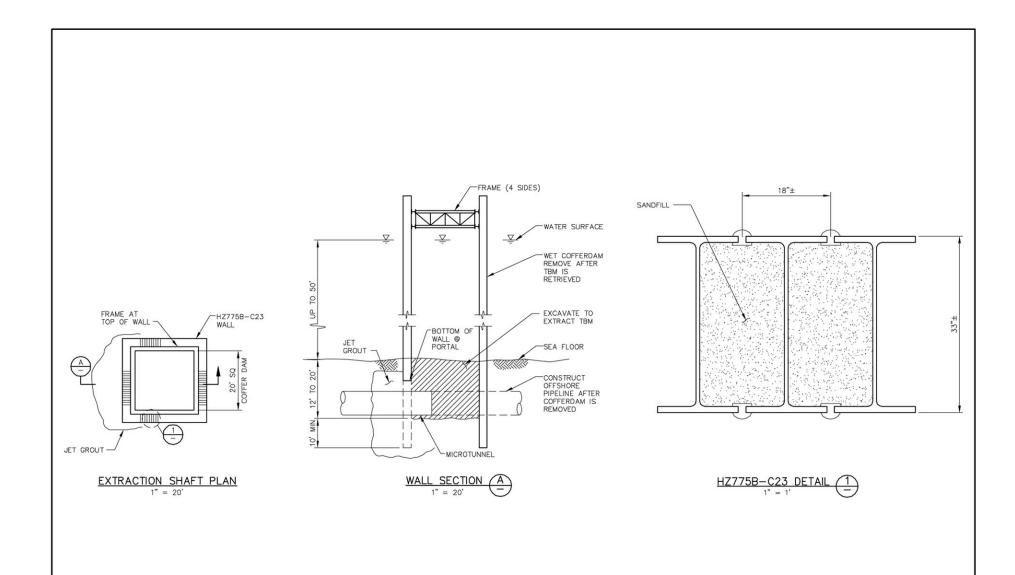


Department of Natural Resources and Parks **Wastewater Treatment** Division

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**Typical Microtunnel Staging Area** BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

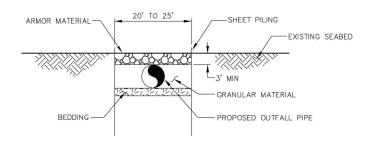
Figure 7





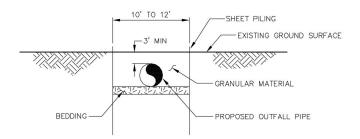
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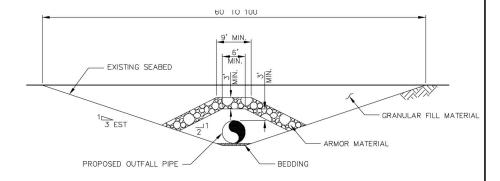
#### NEARSHORE SHEETED TRENCH

NOT TO SCALE



#### ONSHORE SHEETED TRENCH

NOT TO SCALE



#### NEARSHORE UNSHEETED TRENCH

NOT TO SCALE



Department of Natural Resources and Parks **Wastewater Treatment** Division

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Typical Trench Cross Sections BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM